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RESEARCH MEMORANDUM

PRELIMINARY MEASUREMENTS OF THE DYNAMIC LATERAL STABILITY CHARACTERISTICS OF THE DOUGLAS D-558-II (BUAERO NO. 37974) AIRPLANE

By Sigurd A. Sjoberg

Langley Aeronautical Laboratory
Langley Air Force Base, Va.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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SUMMARY

This paper presents some data on the dynamic lateral stability characteristics of the Douglas D-558-II (BuAero No. 37974) airplane. For the airplane in the clean condition, the lateral oscillations are lightly damped. In the landing condition, the airplane performs a constant-amplitude lateral oscillation.

INTRODUCTION

The National Advisory Committee for Aeronautics is engaged in a flight-research program utilizing the Douglas D-558-II (BuAero No. 37974) research airplane. The D-558-II airplanes were procured for the NACA by the Bureau of Aeronautics Department of the Navy and are to be used for flight research in the transonic-speed range. This paper presents some results obtained on the dynamic lateral stability characteristics of the airplane during the first two NACA flights of the airplane.

AIRPLANE

The Douglas D-558-II airplane has a sweptback wing and sweptback horizontal and vertical tail surfaces and was designed for combination turbojet and rocket power. A rocket engine had not yet been installed in the airplane being used in the present investigation. This airplane is powered solely by a J34-WE-40 turbojet engine which exhausts out of the bottom of the fuselage between the wing and the tail. The wing of the airplane has both slots and stall-control vanes. No aerodynamic balance or control-force booster system is used on any of the control surfaces. The airplane has an adjustable stabilizer and speed brakes which are installed on the aft portion of the fuselage. Figure 1 shows a three-view drawing of the airplane and table I presents the physical characteristics of the airplane.

INSTRUMENTATION

Standard NACA instruments were installed in the airplane to measure the following quantities:

Airspeed
Altitude
Normal, longitudinal, and transverse accelerations
Rolling, yawing, and pitching velocities
Elevator, rudder, right aileron, and stabilizer positions
Sideslip angle
Rudder, aileron, and elevator control forces

Airspeed was measured with a swiveling total head and swiveling static head mounted on a boom which extended approximately 8 feet forward from the nose of the airplane. A vane which measured sideslip angle was mounted on the same boom approximately 6 feet forward of the nose of the airplane.

RESULTS AND DISCUSSION

Presented in this paper are some data obtained on the dynamic lateral stability characteristics of the Douglas D-558-II airplane during the first two NACA flights of the airplane. A calibration of the airspeed installation of the airplane has not yet been obtained and therefore the airspeeds, altitude, and Mach numbers presented in this paper are uncorrected for position error and airspeed-head error.

Figure 2 shows a time history of a lateral oscillation of the airplane resulting from abrupt deflection and release of the rudder. This maneuver was made at a Mach number of 0.63 and an altitude of 12,200 feet with the airplane in the clean condition. The data show the oscillation is slow to damp especially at small amplitudes where the oscillation is practically of constant amplitude. The period of the oscillation is 1.6 seconds.

Figure 3 is a time history of a lateral oscillation in the landing condition. This oscillation was again induced by abrupt deflection and release of the rudder. In the landing condition, the airplane performs a constant-amplitude oscillation with a period of approximately 2.7 seconds.

Figure 4 is a time history of a portion of a landing approach made with the D-558-II airplane. During the first part of this time history, between 30 and 44 seconds, the pilot did not attempt to stop the oscillation by use of the ailerons or rudder and the airplane performed a constant-amplitude oscillation. From 44 seconds to 60 seconds the pilot used the ailerons and was able to damp the oscillation. Even though the pilot can damp the oscillation, the oscillation is objectionable particularly during landing approaches and landings because the controls must be moved almost continuously. The rough-air handling qualities of the airplane would probably be particularly objectionable.

CONCLUDING REMARKS

Data were obtained on the dynamic lateral stability characteristics of the Douglas D-558-II (BuAero No. 37974) airplane during the first two NACA flights. These data show that for the airplane in the clean condition, lateral oscillations are lightly damped especially for small amplitudes. In the landing condition, the airplane has neutral oscillatory stability as the airplane performs a constant-amplitude oscillation. These constant-amplitude oscillations can be damped by vigorous use of the controls, but are objectionable to the pilot, however, because almost continuous movement of the controls is required.

Langley Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Air Force Base, Va.

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TABLE I

DIMENSIONS AND CHARACTERISTICS OF THE D-558-II AIRPLANE

Wing:	
Root airfoil section (normal to 0.30 chord)	NACA 63-010
Tip airfoil section (normal to 0.30 chord)	NACA 63-012
Total area, sq ft	175.0
Span, ft	25.0
Mean aerodynamic chord, in.	87.301
Root chord (parallel to plane of symmetry), in.	108.508
Tip chord (parallel to plane of symmetry), in.	61.180
Taper ratio	0.565
Aspect ratio	3.570
Sweep at 0.30 chord, deg	35.0
Incidence at fuselage center line, deg	3.0
Dihedral, deg	-3.0
Geometric twist, deg	0
Total aileron area (aft of hinge), sq ft	9.8
Total flap area, sq ft	12.58
Horizontal tail:	
Root airfoil section (normal to 0.30 chord)	NACA 63-010
Tip airfoil section (normal to 0.30 chord)	NACA 63-010
Area (including fuselage), sq ft	39.9
Span, in.	71.8
Mean aerodynamic chord, in.	41.75
Root chord (parallel to plane of symmetry)	53.6
Tip chord (parallel to plane of symmetry)	26.8
Taper ratio	0.50
Aspect ratio	3.59
Sweep at 0.30 chord line, deg	40.0
Dihedral, deg	0
Elevator area, sq ft	3.78
Vertical tail:	
Airfoil section (parallel to fuselage center line)	NACA 63-010
Area, sq ft	36.6
Height from fuselage center line, in.	98.0
Root chord (parallel to fuselage center line), in.	146.0
Tip chord (parallel to fuselage center line), in.	44.0
Sweep at 0.30 chord, deg	49.0
Rudder area (aft of hinge line), sq ft	6.15
Fuselage:	
Length, ft	42.0
Maximum diameter, in.	60.0
Fineness ratio	8.40
Speed-retarder area, sq ft	5.25
Power plant	J-34-WE-40
Airplane weight (full fuel), lb	10,554
Airplane weight (no fuel), lb	8,994
Center-of-gravity locations:	
Full fuel (gear down), percent M.A.C.	23.4
Full fuel (gear up), percent M.A.C.	23.9
No fuel (gear down), percent M.A.C.	24.6
No fuel (gear up), percent M.A.C.	25.2

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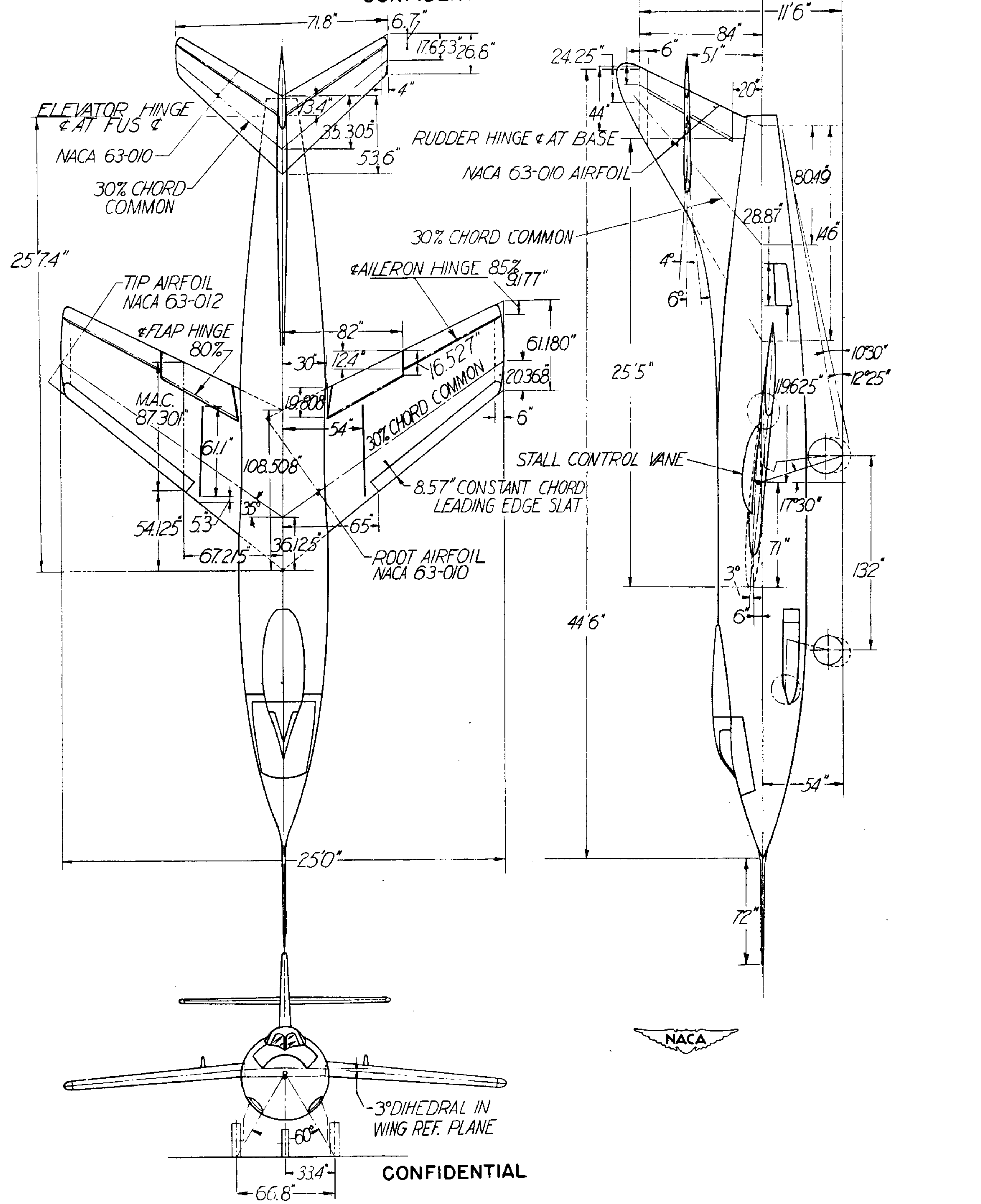

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Figure 1.– Three-view drawing of Douglas D-558-II (BuAero No. 37974).

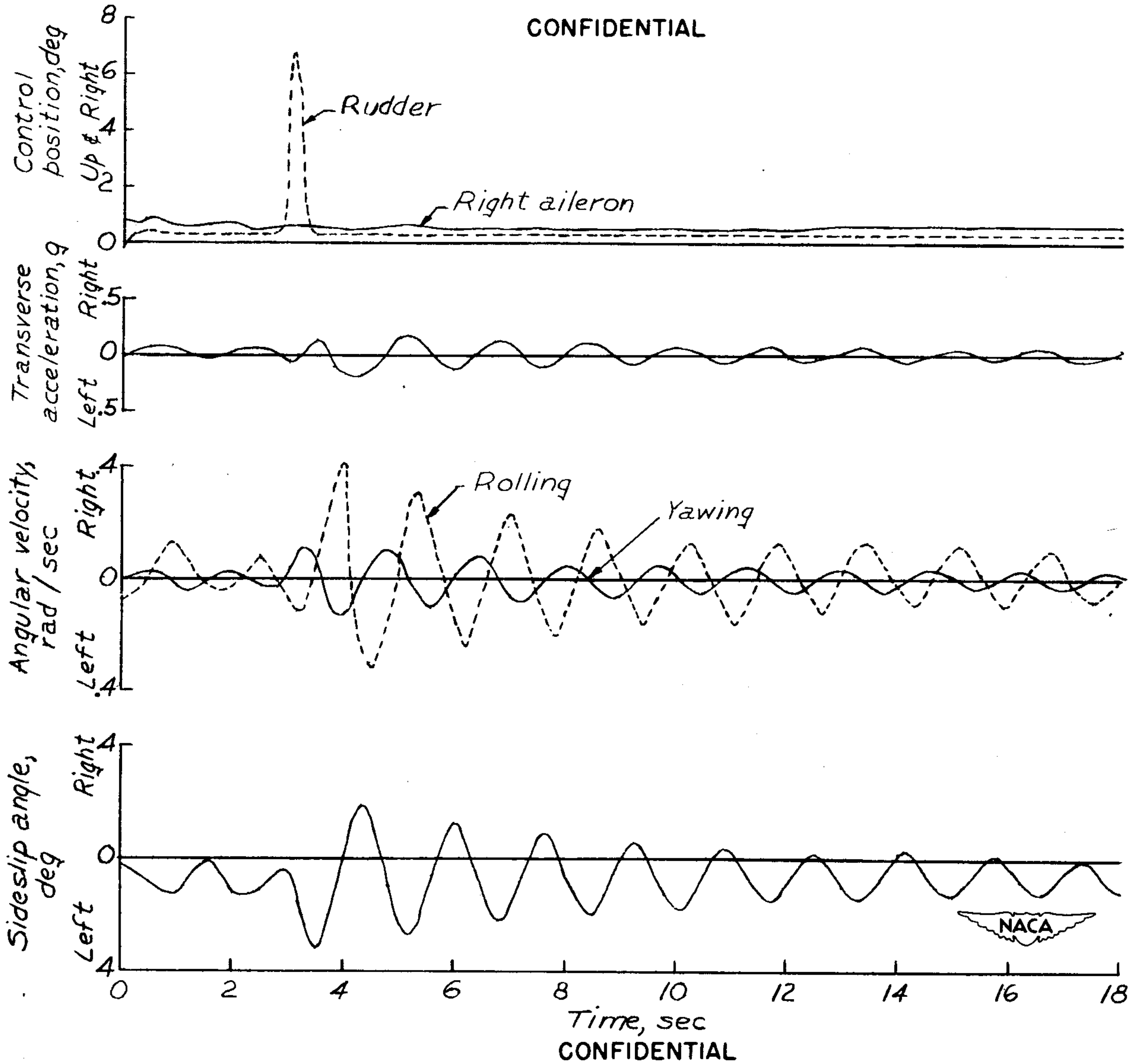

Figure 2.– Time history of lateral oscillation of Douglas D-558-II (BuAero No. 37974) airplane in the clean condition. Flaps up; gear up; slats locked; M = 0.63; h = 12,000 feet.

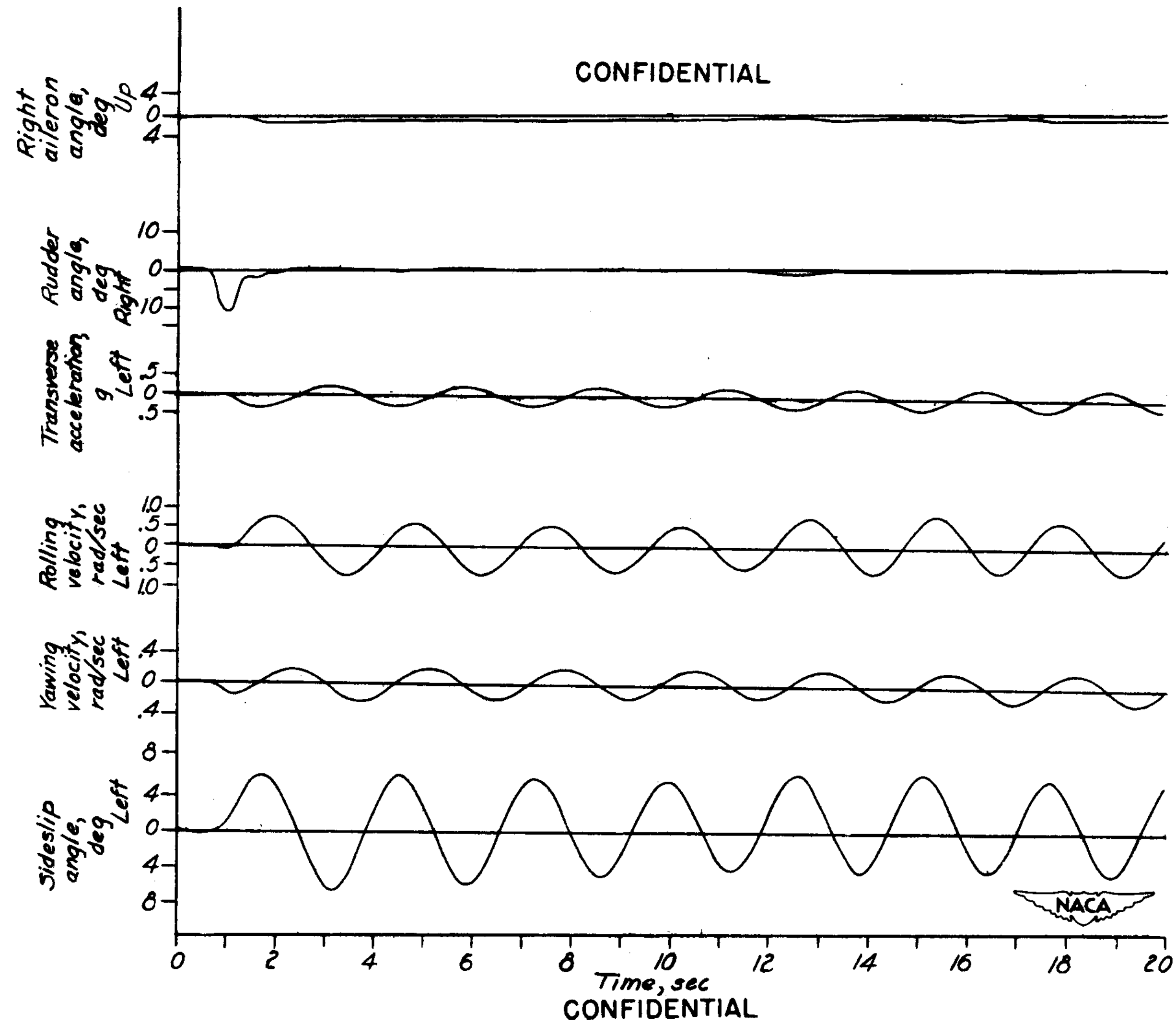

Figure 3.– Time history of lateral oscillation of Douglas D-558-II (BuAero No. 37974) airplane during a landing approach. Flaps down; gear down; slats unlocked; at 0 second, V_1 = 244 miles per hour h = 13,960 feet; at 20 seconds, V_1 = 269 miles per hour, h = 10,900 feet.

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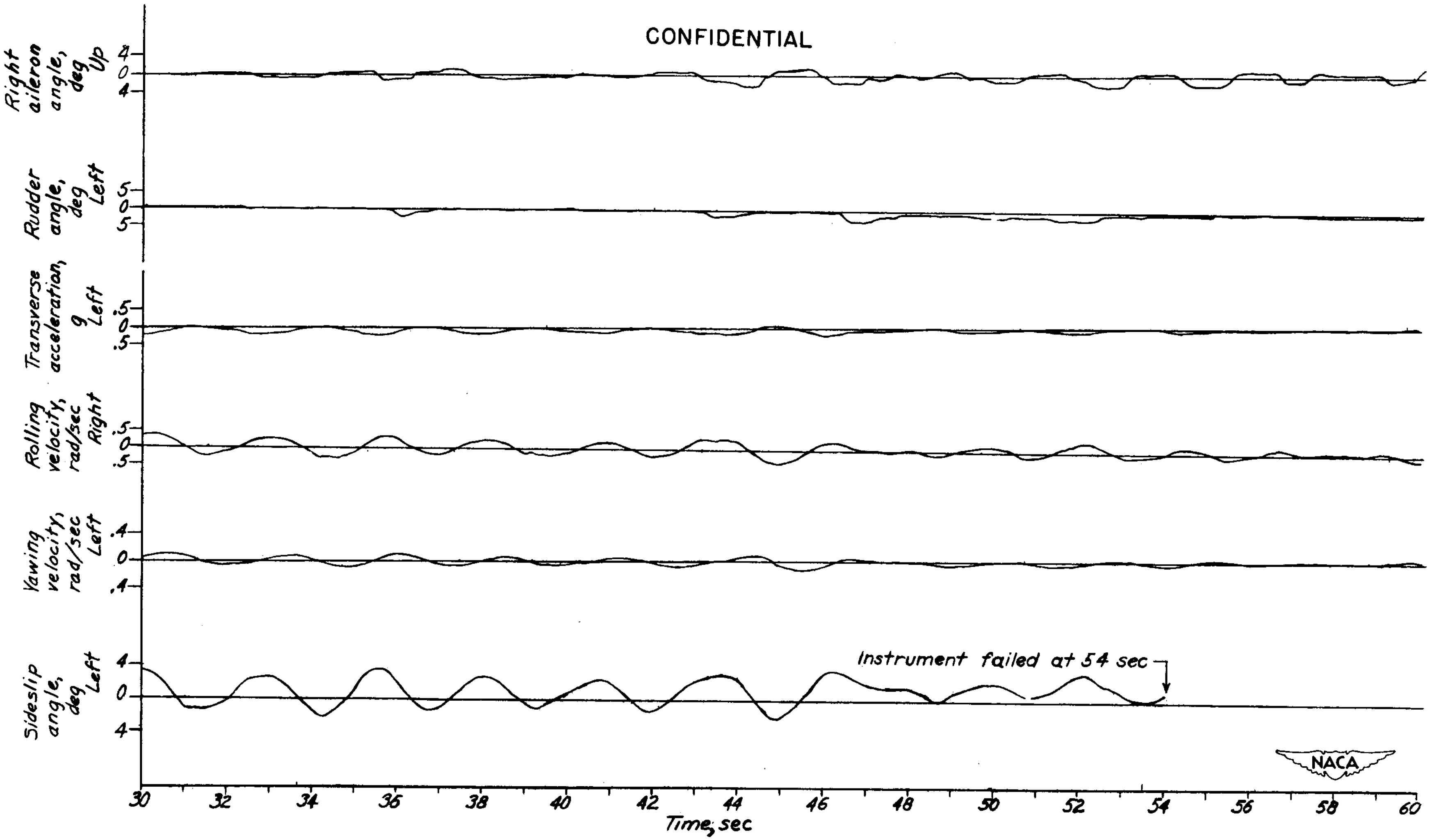

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Figure 4.– Time history of lateral oscillation of Douglas D-558-II (BuAero No. 37974) airplane during a landing approach. Flaps down; gear down; slats open; at 30 seconds, V_1 = 240 miles per hour, h = 4620 feet; at 60 seconds, V_1 = 184.5 miles per hour, h = 2220 feet.